added by himself in a footnote, that the "solar spectrum does produce the complementary colors in the after-image." For if the so confidently proclaimed law did not turn out true for saturated colors, the simplest of all perceptions of color, why did not our author suspect that he was on dangerous ground? As for the rest of his article, it is really no contribution to science, but contains an effort to refute the doctrine of fatigue in favor of some quite unintelligible explanation of after-pictures, and to edify the reader by general reflections.

We are far from being fully persuaded of the truth of the common theory, and have nothing ourselves to add to the discussion of the subject, save the present note of warning to solitary observers of mental phenomena. Let us all observe, by all means, and independently; but let us know what other people have said, or at least what the greatest men have said. Mr. Hodges is actually capable of believing and saying, at the outset of his article, such words as these: "I should add, that brief references to after-images with closed eyes may be found in Helmholtz's great work on Physiological optics, in Dr. Foster's Text-book of physiology, and in a few other works; but the fact that neither of them contains any detailed experiments (?) such as I am about to describe, induces me to hope," etc. And this Mr. Hodges could write, presumably with Helmholtz's book, § 23 and all, before him. What he is about to describe we have indicated. He looked at a window, and then covered his eyes; afterwards he tried the sun, colored cards, etc.; then he asked two or three people to try similar experiments; and then he wrote his article. And now who shall say that every intelligent man understands how to use even the best-known and best-arranged books? And why should the pages of the *Nineteenth century* be thus occupied?

JOSIAH ROYCE.

LAKES OF THE GREAT BASIN.

As the geological observations given in a recent paper by Prof. E. D. Cope[1] relate to a region somewhat familiar to me, I venture to offer the following comments.

Under the heading of 'Preliminary observations' it is stated that the geologists of the Fortieth-parallel survey have shown that Lake Bonneville existed during tertiary time. It must be known to every one, however, who has read vol. i. of the reports of the survey mentioned, that this lake is there classed as quaternary: it has been so regarded by all geologists who have made any considerable study of the surface geology of Utah. Lake Lahontan is supposed, with good reason, to have been contemporaneous with Lake Bonneville, and therefore also of quaternary age. Recent observations tend to prove that the last great rise of these lakes was later than the greatest extension of the Sierra-Nevada glaciers, and perhaps synchronous with the Champlain epoch of the Atlantic coast.

Lake Bonneville was not named by the geologists of the Fortieth-parallel survey, as stated by Professor Cope, but was first so designated by Mr. Gilbert.[1]

The list of lakes given as now existing in the Lahontan basin should also include Honey Lake, California, as the valley in which it occurs formed a bay of the old lake with over three hundred feet of water. A map, showing the outline of Lake Lahontan as recently determined, will appear in the third annual report of the U. S. geological survey.

The prediction "that it will be shown that a third lake existed in Oregon, north of the supposed northern boundary of Lake Lahontan," has proved correct only in part. A geological reconnoissance conducted by myself in this region in the spring of 1882 has shown that the Great Basin, north of the hydrographic rim of Lake Lahontan, was divided during quaternary time into not less than ten independent hydrographic areas, each of which held a lake of small size, as compared with Bonneville and Lahontan.

The statement that "the lakes of the Great Basin in Nevada and Oregon diminish in alkalinity as we approach the Sierra Nevada Mountains," meets with a notable exception in Moro Lake, California, which lies at the immediate base of the highest portion of the mountains, but is yet, according to an analysis of its water made for me by Dr. F. W. Taylor, far more alkaline than any of the lakes of the Lahontan basin, excepting the soda-ponds at Ragtown, Nev.

Professor Cope also says, that "the lakes most remote from the mountains are not inhabited by fish, their only animal population being crustacea and the larvae of insects." That this conclusion is too broad is illustrated by the life of Humboldt Lake, which is inhabited by both fish and mollusks, and also that of Ruby and Franklin lakes, situated still farther eastward, which abound in molluscan life. That the freshness of lakes, and consequently their inhabitability by fishes and mollusks, do not depend on their relation to mountains, or even on the existence of an outlet, can be shown by numerous examples in the Great Basin. The only explanation of the apparent anomaly of an enclosed lake of comparative freshness (with less than one per cent of saline matter in solution) in the nearly desiccated basin of a far larger lake, which never overflowed, has been suggested by Mr. Gilbert.[2] His hypothesis is, that such lakes owe their freshness to complete desiccation and the burial of the precipitated salts beneath plaza deposits. When water re-occupies such a basin, the imprisoned salts may not be redissolved. It is evident that this process might take place in any part of an arid region like the Great Basin, whether it be near or remote from mountain ranges.

The locality mentioned on p. 137 as having furnished fossil remains is included within the still distinct beach-lines of an ancient lake which once filled the Christmas Lake and Silver Lake valleys. The shells collected at this locality by myself have been

[1] On the fishes of the recent and pliocene lakes of the western part of the Great Basin, and of the Idaho pliocene lake (*Proc. acad. nat. sc. Philad.*, June, 1883).

[1] Wheeler survey, vol. iii. pp. 88, 89.

[2] Second ann. rep. of U. S. geol. surv., p. 177.

examined by Mr. R. Ellsworth Call, who reports the following species: Aphaerium dentalum Haldeman, Pisidium ultramontanum Prime, Helisoma trivolvis Say, Granulus vermicularis Gould, Limnophysa bulimoides Lea, Carnifex Newberryi Lea, Valvata virens Tryon.

The mingling of the blackened and mineralized bones of horses, camels, elephants, edentates, etc., with the shells enumerated above, presents a puzzling association of extinct tertiary(?) mammals with quantities of shells of living species, which we had hoped Professor Cope's studies would elucidate.

The presence of 'worked flints,' mingled with the fossil bones, is a matter of but little significance; as the bones occur on the surface, and might have had arrow-heads, etc., scattered among them at a very recent date. There is no evidence that the fossil animals, and the people who chipped the flints, were contemporaneous.

The valley of the Warner Lakes is referred to as a 'fractured anticlinal.' Again, the same expression is used in describing Silver Lake. We believe, however, that geologists familiar with the progress of exploration in the Far West during the past ten years would class these basins as monoclinal valleys, of the Great Basin type.[1] The Warner valley has a profound fault along both the eastern and western borders, and is enclosed to a great extent by lofty fault-scarps.

The Abert Lake basin also owes its formation to displacements. The lake occurs at the base of a great fault-scarp, forming a cliff two thousand feet high, and covers the depressed edge of a thrown block.

In the passage relating to Abert Lake (p. 138), the reader is left in doubt as to whether the lake, or the Chewaucan River, abounds in trout. Later, however, three species of fish are credited to Abert Lake. My own experience has been, that trout are abundant in the river, and absent from the lake; although they perhaps could exist in the latter in the immediate vicinity of the mouth of the Chewaucan River (frontiersmen who are familiar with the lake say that it is uninhabited by fish). During my own examination I found its waters swarming with 'brine shrimps' and the larvae of insects, but never saw a trace of piscine life. Its waters are strongly alkaline, and utterly unfit for culinary purposes. In its physical properties the water of Abert Lake resembles the brines of Sumner Lake (Oregon), Moro Lake (California), and the soda-ponds (near Ragtown, Nev.), all of which are too strongly alkaline to be inhabited by fishes. It is not evident on what authority Professor Cope ascribes a fish fauna to this lake, as on p. 138 it is stated distinctly that he did not get a near view of it.

From a study of the geographical distribution of the fishes in the lakes of the Great Basin, Professor Cope has found that the larger fishes inhabiting the lakes in northern Nevada and south-eastern Oregon are different from those of the lakes of the Bonneville basin. This is an interesting determination; as the former basins were mostly without outlets during the quaternary, while the latter became tributary to the Columbia.

The effect of alkalinity on the growth of fishes has been noted by Professor Cope to some extent, and is evidently a study that might lead to interesting geological conclusions. The comparison of the faunas of Pyramid and Tahoe lakes would perhaps show the effect of salinity and alkalinity on the species of fishes which probably inhabit both lakes. Pyramid Lake, it will be remembered, is supplied almost wholly by the Truckee River, the outlet of Lake Tahoe.

Before concluding that "all the species of Pyramid Lake are peculiar to it, excepting Catostomus tahoensis," it would be desirable to compare its fishes with those of Walker Lake. As these two lakes are quite similar in chemical composition, and both occur in the Lahontan basin, it seems probable that their abundant faunas would be found nearly identical. One species of trout, at least, seems to the writer, from superficial examination, to be common to the two.

The second part of Professor Cope's paper is devoted to the description of the fossil fauna of 'Idaho Lake.' This lake existed in eastern Oregon and western and southern Idaho during pliocene time. No body of water represents it at present; and the fish-remains found in its sediments differ from those of the Oregon basin, both recent and fossil. The extent of this ancient lake is not known. Its sediments are named the 'Idaho formation,' but no typical exposure is described or in any way indicated. Even the locality at which the fossil bones were collected is, for some unstated reason, withheld. This method is to be regretted; as Professor Cope does not stand alone in making geological divisions on purely paleontological grounds, without attempting to describe or locate the formations named. If this practice is persisted in, it can only lead to confusion.

Of the twenty-two species of fossil fishes described, eight are new. Besides these, the sediments of the Idaho Lake have furnished three species of crawfish which were reported by Professor Cope some years since. The mollusks, it appears, have already been described by F. B. Meek. Both the vertebrate and invertebrate fossils of the formation determine it to be lacustrine and fresh.

Although we have ventured to take exception to a number of statements in the paper under review, yet we welcome it as adding materially to our knowledge in a field that had previously been but little studied.

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[1] See 'Basin Range structure,' Geol. of the Uintah Mountains, Powell, p. 16.

THE DEFINITION OF MEAN SOLAR TIME.[1]

THE proper definition of mean solar time appears to me a very simple matter, and to have nothing arbitrary about it. The mean sun is merely an imaginary body which is supposed to move uniformly

[1] Paper by Prof. J. C. Adams of Cambridge, at the December meeting of the Royal astronomical society. From *The observatory*, February.